



House prices and rents variations due to Transit Oriented Development policies

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Abstract

The concept of Transit Oriented Development (TOD) deals with the development of a mixed-use, compact, walkable neighborhood with the objective of encouraging residents to live near and use public transit. A TOD neighborhood is typically characterized by a transit station, public spaces and by a walkable street network connecting residential and commercial buildings to that station within a 800m radius. TOD is based on the contrast to the auto-dependent behaviour, which has characterized the development pattern in the United States since the Second World War, due to the growth of car use, highway expansion, and suburbanization.

Studies on the impacts of transit rail on residential property values have provided interesting results in many urban contexts. However, for the case study of Italy, the literature is very poor with the exception of some experiences reported for the cities of Milan, Turin and Genoa, where the impacts of these initiatives have not really been quantified. The aim of this paper is to fill this gap, indeed through the case study of Naples, a city in the south of Italy, the impacts of metro stations on house prices and on rents have been analysed.

The Campania Regional Metro System (RMS) project is considered one of the most ambitious examples of rail-based public transport policies currently implemented in Italy. The project started in Naples, the main city of Campania region, in 1997, and was extended to the regional level in 2000. The focus here will be on the seven lines of the metro network of Naples and on the analysis of the impacts of these stations on house prices. In this context, several international architects were involved in the RMS to ensure high esthetic quality standards for both the new and renewed stations. In addition to purely architectural elements, the stations are characterized by contemporary art pieces, improving the esthetic quality of the terminal and in the surrounding area, thus increasing its the quality of life. Four recently inaugurated stations are described in detail. For them, being part of the Art Metro project, impacts on house prices and rents will be reported.

Keywords: Transit Oriented Development; neighborhood renewal; house prices change; rents change.

1. Introduction

The concept of Transit Oriented Development (TOD), first introduced by (Calthorpe, 1993), deals with the development of a mixed-use, compact, walkable neighborhood with the objective of encouraging residents to live near and use public transit (Xu *et al.*, 2017). A TOD neighborhood is typically characterized by a transit station, public spaces and by a walkable street network connecting residential and commercial buildings to that station within a 800 m radius (Feudo, 2014).

TOD is based on the contrast to the auto-dependent behaviour, which has characterized the development pattern in the United States since the Second World War, due to the growth of car use, highway expansion, and suburbanization. The negative impacts of this new trend, ranging from traffic congestion, air pollution, urban sprawl (Cervero, 2008; Curtis and Scheurer, 2017), led to the promotion of TOD policies. For example Maryland has placed Legislation since 1998 in order to facilitate TOD as a way of concentrating development at transit stations to increase transit ridership.

After the America experience, in European as well as in Asian cities (Dittmar and Ohland, 2003; Yang *et al.*, 2013) several TOD policies have been introduced.

Three can be the categories of TOD policies: (1) development of new residential areas in transit service area; (2) development of new employment centers in transit service area; (3) simultaneous development of residential areas and employment centers in transit service area (Wang *et al.*, 2016). All the three categories of policies are likely to increase transit market share by reducing car use and traffic congestion.

Studies on the impacts of transit rail on residential property values in settings as Philadelphia, Washington, D.C., Miami, Portland, and the San Francisco Bay Area have provided mixed results. A study of residential properties near the Lindenwold Line in Philadelphia reported that access to rail created an average housing value premium of 6.4 percent (Voith, 1993). In a study of three light rail systems (Santa Clara County, San Diego, and Sacramento), a heavy rail system (BART), and a commuter rail system (CalTrain) in California, Landis *et al.* (1994) found evidence of capitalization effects on single-family housing prices, with heavy rail systems conferring the biggest benefits.

In recent years TOD policies have been promoted in several European cities (Givoni and Banister, 2010). In Munich an urban planning process, based on the principles of TOD, was developed with the aim of increasing urban development in the catchment areas of public mass transport (Papa *et al.*, 2013).

In the South Wing of the Randstad area, a regional Transit Oriented Development program, named the StedenbaanPlus, was implemented in 2006 (Geurs *et al.*, 2012). The objective was to promote urbanization around more than 30 railway stations and improve access to station areas for buses and bikes.

Another example of TOD is for the Copenhagen city region in the Finger Plan 2007 (Danish Ministry of Environment, 2007). The latter was based on the principle of “revitalising station proximity” (Knowles, 2012), thus promoting urban development in close connection with the development of transport infrastructure and transport services.

For the case study of Italy, very poor is the literature concerning TOD policies, with the exception of some experiences reported for the cities of Milan, Turin and Genoa, where the impacts of these initiatives have not really been quantified (De Robertis, 2010; Staricco, 2015).

The aim of this paper is to fill this gap, indeed through the case study of Naples, a city in the south of Italy, the impacts of the metro stations inauguration on the number of residents, on house prices and on rents have been analysed and quantified. This paper is organized as follows. In section 2 the case study of the TOD policy in Naples is described. Section 3 deals with the methodology, while in section 4 four recently inaugurated stations are proposed with their impacts. Conclusions and further perspectives are presented in section 5.

2. The case study

The Campania Regional Metro System (RMS) project is considered as one of the most ambitious examples of rail-based public transport policies currently implemented in Italy (Cascetta *et al.*, 2015). The project started in Naples, the main city of Campania region in the south of Italy, in 1997, and was extended to the regional level in 2000. The investment in infrastructures and rolling stock was about €9 billion. In addition to new railway lines, new stations and parking facilities, a number of other aspects were implemented with the aim of improving the quality of the public transport service (Cascetta and Pagliara, 2008). The total length of the railway network of Campania increased of about 14%, from 1179 km (in the year 2000) to 1349 km in 2015. At the same time, in order to improve accessibility and interconnectivity, a strategic role was assigned to the stations of the RMS project, i.e. building new stations and also up-grading the existing ones. At project completion, the number of new or upgraded stations will increase by 30%, i.e. from 340 to 442.

In this context, several international architects were involved in the RMS to ensure high esthetic quality standards for both the new and renewed stations. In addition to purely architectural elements (forms, colors, space distribution and lighting) the stations are characterized by contemporary art pieces, improving the esthetic quality of the terminal and in the surrounding area (Cascetta *et al.*, 2015).

The metro lines in the city of Naples are seven. Specifically, Line 1 currently links the northern part of the city of Naples to its city centre, passing through the hilly boroughs of Colli Aminei and Vomero (see Fig. 1). It has a total length of 18 km and is made up of 18 stations and 4 interchange nodes. Line 2 is the oldest one in Naples and serves the city from the East to the West. It is made up of 11 stations including 6 interchange nodes. Line 3-4, formerly known as Circumvesuviana, link the city centre of Naples with the North-East and the South-East parts of the city. They have 10 and 7 stations respectively, with 4 interchange nodes. Line 5, previously named Circumflegrea, passes through an area known as Campi Flegrei.

Line 6 has a current length of only 6 km, linking the borough of Fuorigrotta with the one of Mergellina. Final stops are Mostra and Mergellina with interchange nodes with Lines 2 and 7. Two stations will be opened in the coming two years in the Chiaia borough and one more in Municipio square (with an interchange node with Line 1). Finally, Line 7, formerly known as Cumana, links the city centre with the town of Pozzuoli.



Source: Authors' elaborations

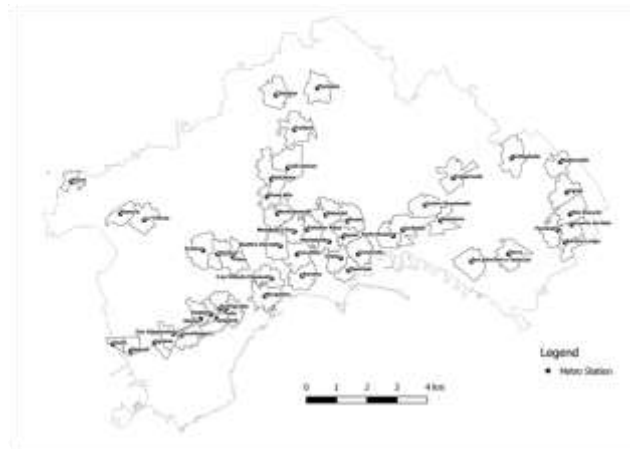
Figure 1. Metro stations and lines

3. The methodology

In order to evaluate the impacts of the metro stations on residents, data was collected from ISTAT, i.e. the Italian census. House prices data was obtained from Osservatorio del Mercato Immobiliare (OMI), which provides information for each OMI zone of the city of Naples.

A first analysis was carried out by including all the metro stations of Naples. Stations were identified on a GIS and for each of them a catchment area was defined (Pagliara and Papa, 2011), with a radius of 500m from the station.

A catchment area is defined as an aggregation of census particles Fig. 2 shows the stations and the corresponding catchment areas.



Source: Authors 'elaborations

Figure 2. Metro stations and their catchment areas

Different indexes for the residents were introduced with the objective of evaluating and interpreting the impacts of metro stations. Data was collected from the 14th and 15th Italian Census (ISTAT, 2001 and 2011) and from the Statistical Bulletin of Naples (2005 and 2013).

Census provides the number of residents for each particle. In order to have intermediate data as well an estimate, based on the Statistical Bulletin data, was made for the years 2005 and 2016.

The indexes are:

- Population per borough: calculated in 2001 and 2011 (Census years), summing up the population of each particle within a borough:

$$P_{distr} = \sum_{i=1}^n P_i \quad (1)$$

where n represents the number of particles within a given borough.

- Percentage of people living in a given particle of the borough:

$$\%P_{part} = \frac{P_{part}}{P_{distr}} \cdot 100 \quad (2)$$

- since the population per borough and the percentage that lives in a single particle (supposed equal to the percentage in 2001) were available, the population in each particle was calculated in 2005. The total population of Naples was available in 2016, therefore the number of residents for each borough was evaluated taking the percentages given by the 2013 Statistical Bulletin:

$$P_{part2005} = \frac{\%P_{part2001} \cdot P_{distr2005}}{100} \quad (3)$$

$$P_{part2016} = \frac{\%P_{part2011} \cdot P_{distr2016}}{100} \quad (4)$$

The population of each particle within a catchment area was summed up in order to compute the residents of a given catchment area. A percentage change index was calculated to evaluate the demographic impacts of the metro line:

$$\Delta \%res_i = \sum_{k=1}^p \frac{res_{2011k} - res_{2005k}}{res_{2005k}} \cdot 100 \quad (5)$$

$$\Delta \%res_i = \sum_{k=1}^p \frac{res_{2016k} - res_{2011k}}{res_{2011k}} \cdot 100 \quad (6)$$

where:

- res_{yeark} are the residents in the census particle k in a given year.
- i is the catchment area.

Concerning the house price changes, data was taken from OMI to estimate the economic impacts. Information was available from 2005 to 2015, while data in 2016 was obtained from the website borsinoimmobiliare.it.

The purpose here is to get an average house price per year for each catchment area. Each census particle was associated with the house price given by the OMI zone including it. Catchment areas are made up of several Census particles, therefore the house price of a catchment area is given by the following expression:

$$hp = \frac{\sum_{k=1}^p price_k}{p} \quad (7)$$

where:

- hp_k is the average house price of particle k ;
- p is the number of census particles k within the catchment area i .

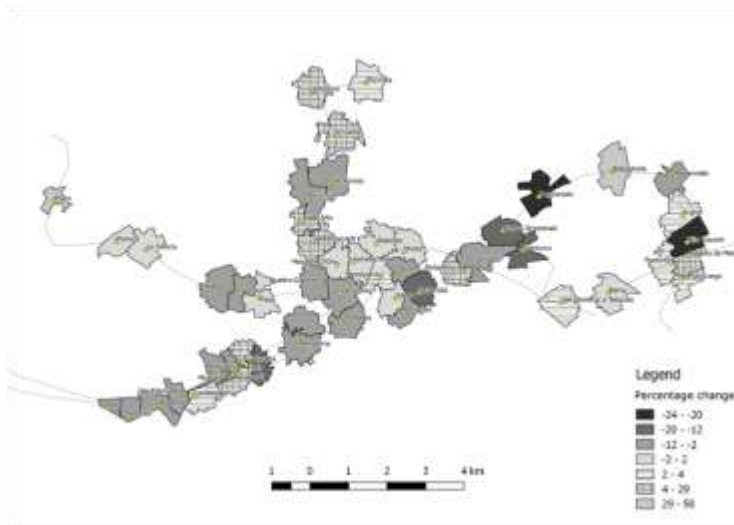
The percentage changes were calculated as:

$$\bullet \Delta \%hp_k = \frac{(hp_{2011} - hp_{2005})}{hp_{2005}} \cdot 100 \quad (8)$$

$$\bullet \Delta \%hp_k = \frac{(hp_{k2016} - hp_{k2011})}{hp_{k2011}} \cdot 100 \quad (9)$$

3.1. Results

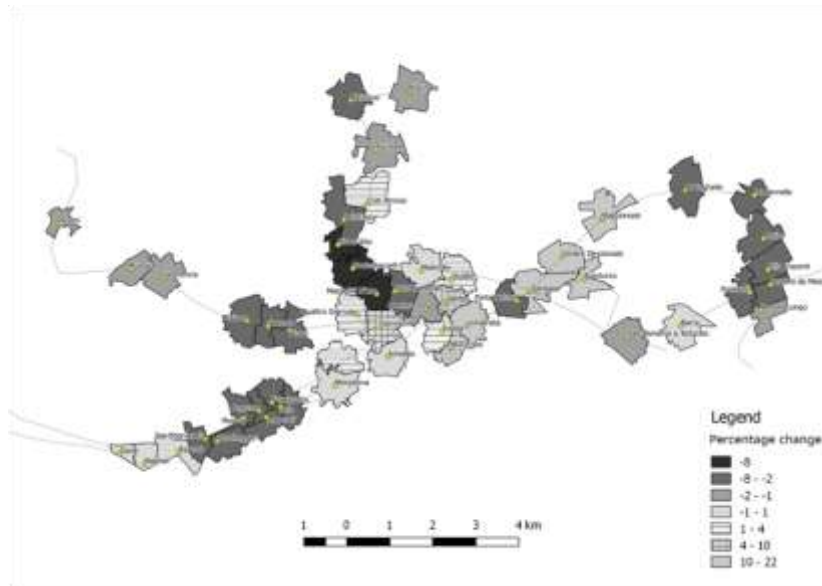
The average population change percentage in the city of Naples in the time period 2005-2011 is -2%. The relative percentage change of population in the catchment areas was calculated compared it with the city average. Fig. 3 shows that most of the catchment areas experience greater population changes than the average value.



Source: Authors' elaborations

Figure 3. Population change in station catchment areas compared to the city average, time period 2005-2011

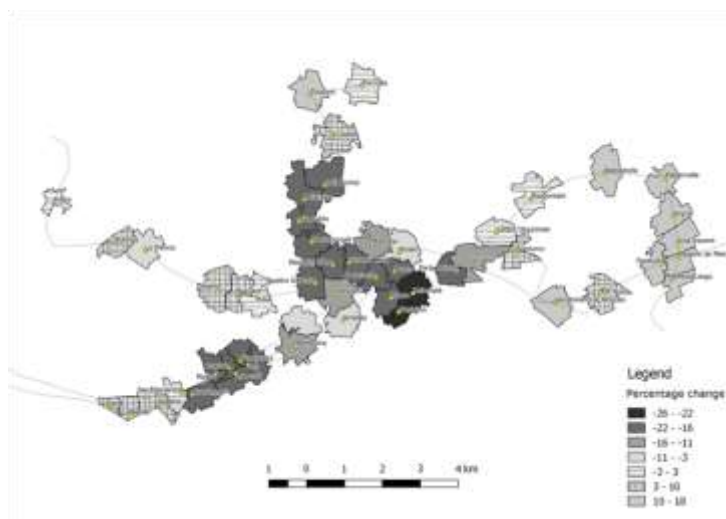
The most negative change is present in some station catchment areas placed in the East part of the city. During the time period 2011-2016 a change is evident (see Fig. 4). In some station catchment areas of the city centre a positive population change is registered, particularly for those stations inaugurated during this period. Garibaldi station catchment area experiences a strong increase in residents, while a decrease is present in the previous period. The average change in Naples is +1% during this period.



Source: Authors' elaborations

Figure 4. Population change in station catchment areas compared to the city average, time period 2011-2016

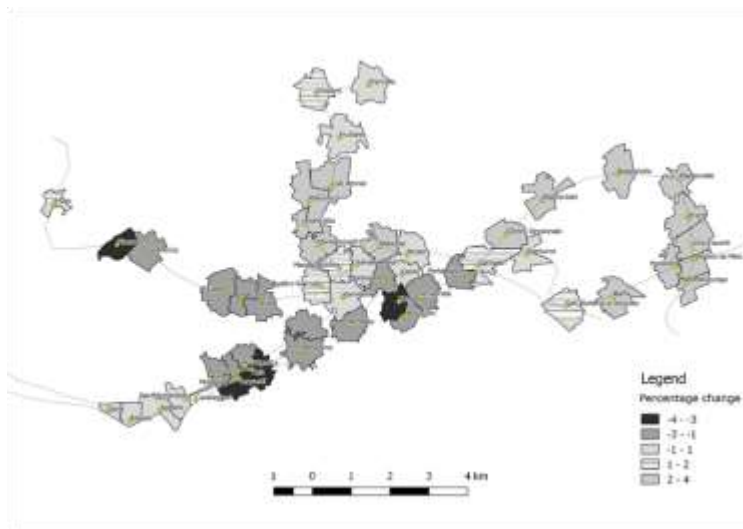
The average change in house prices is +17% during the first period considered, i.e. 2005-2011. Changes of house prices compared with the average change of Naples were calculated and represented in Fig. 5. A decrease in the city centre station catchment areas is evident. On the contrary, in peripheral station catchment areas an opposite trend is evident.



Source: Authors' elaborations

Figure 5. House price change in station catchment area compared to city average, time-period 2005-2011

The average change in house prices is -22% during the time-period 2011-2016. The trend, in this case, is very similar to that of the city average value. Some stations located in the Vomero borough experience a decrease lower than the average one, while in the city centre station catchment areas, house prices decrease more than the city average value (see Fig. 6).



Source: Authors' elaborations

Fig. 6 - House price change in station catchment area compared to city average, time-period 2011-2016

4. University, Toledo, Garibaldi and Municipio stations

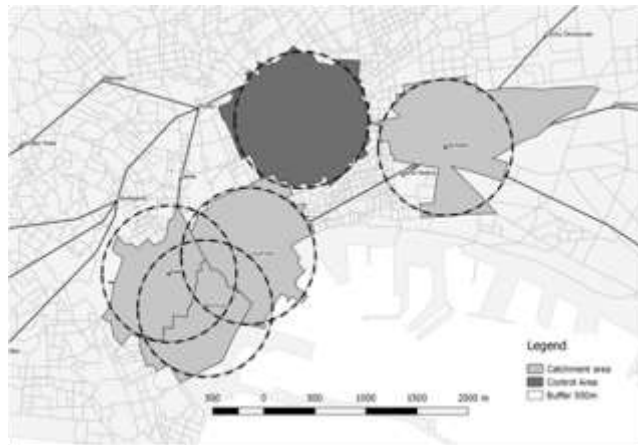
Four new stations of the metro Line 1 were inaugurated between 2011-2015. These stations are part of the ART METRO project. On a more qualitative point of view, so-called "art stations" have been recognized as the most attractive, at the international level (e.g. the new Toledo Station of the Metro Line 1, was first nominated by The Daily Telegraph (2013), and then by the CNN (2014) as the most impressive metro station in Europe) a view shared by travellers and tourists. These results are connected to the type of the decision-making process related to planning and designing the various elements of the RMS (Cascetta *et al.*, 2015).

The new stations are:

- METRO STATION UNIVERSITY was inaugurated on the 26th March 2011. It is located close to the port, in a borough which is an important commercial area and where some universities are placed.
- METRO STATION TOLEDO was opened in 2012. It is nearby Toledo street in the heart of the city and very close to two densely populated boroughs.

- METRO STATION GARIBALDI, opened in 2013, it is a key rail node since it connects Line 1 with the metro lines 2-3-4 and most of all national railway lines.
- METRO STATION MUNICIPIO, opened in 2015, links Line 1 with Line 6. It is located in Municipio square, close to the port. It also serves densely populated areas.

For these four stations a catchment area was identified as an aggregation of Census particles within a 500m radius (see Fig. 7). Moreover a control area, located in the city centre of Naples and nearby the catchment areas, was defined. A control area is an area which has not experienced any investment in rail infrastructure.



Source: Authors' elaborations

Figure 7. The four stations' catchment areas and the control area

Rents' percentage changes were also calculated using the same approach as the one adopted for house prices:

$$\Delta\%r_i^t = \frac{(r_{i2011}^t - r_{i2005}^t)}{r_{i2005}^t} \cdot 100 \quad (10)$$

$$\Delta\%r_i^t = \frac{(r_{i2016}^t - r_{i2011}^t)}{r_{i2011}^t} \cdot 100 \quad (11)$$

Population changes were calculated both in the catchment and control areas. Results (see Table 1 and Fig. 8) show that a population growth is present in the control area during the first time period 2005-2011, before the stations opening. On the other hand, in the same time-period, when the four new stations were not inaugurated yet, in the station catchment areas a general decrease, even more significant than city average, is present. Bovio square, where the METRO STATION UNIVERSITY is now located, a percentage change of -18% is registered. A motivation can be found in the road works which had a negative impact on the quality of the whole area during that period.

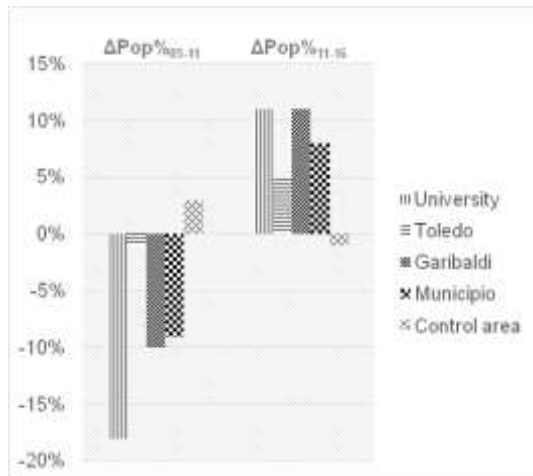
The scenario is different during the second time period. Specifically, in the control areas a similar percentage change than city average is present, while the population grows in the new metro station catchment areas. The METRO STATION UNIVERSITY

catchment area experiences the highest percentage change due also to the completion of road works and the opening of the station in 2011.

Area	Pop ₂₀₀₅	Pop ₂₀₁₁	Pop ₂₀₁₆	ΔPop% ₀₅₋₁₁	ΔPop% ₁₁₋₁₆
University	9557	7879	8748	-18%	+11%
Toledo	18987	18782	19716	-1%	+5%
Garibaldi	13015	11727	13059	-10%	+11%
Municipio	3229	2946	3182	-9%	+8%
Control area	24535	25212	24902	+3%	-1%
Naples average	984242	961106	970185	-2%	+1%

Source: Authors' elaboration

Table 1. Population percentage change in station catchment and control areas



Source: Authors' elaboration

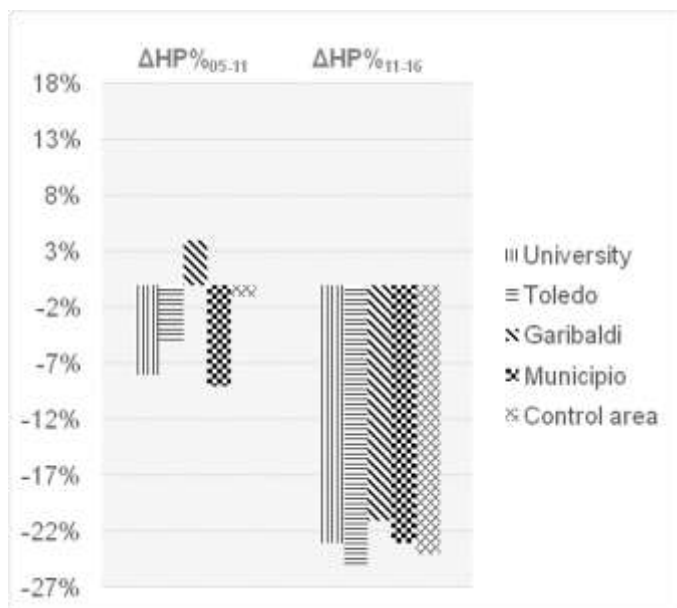
Figure 8. Population percentage change in station catchment and control areas

The trend of house prices (see Table 2 and Fig. 9) is negative in both the station catchment and control areas in the time period 2005-2011, while the city average is +17%. The scenario is not different during the subsequent time period 2011-2016, since a decrease is still present, although a positive impact of the stations' inauguration was expected.

Area	HP ₂₀₀₅	HP ₂₀₁₁	HP ₂₀₁₆	$\Delta\text{HP}\%_{05-11}$	$\Delta\text{HP}\%_{11-16}$
University	3744	3447	2642	-8%	-23%
Toledo	4324	4112	3071	-5%	-25%
Garibaldi	2417	2504	1980	+4%	-21%
Municipio	4668	4247	3252	-9%	-23%
Control area	2796	2754	2084	-1%	-24%
Naples average				+17%	-22%

Source: authors' elaboration

Table 2. House prices percentage change in station catchment and control areas



Source: Authors' elaboration

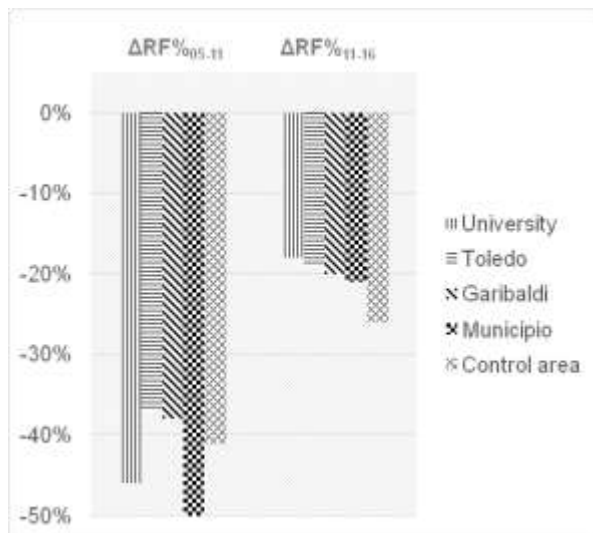
Figure 9. House price percentage change in station catchment and control areas

Rent percentage changes (see Table 3 and Fig. 10) are consistent with the population trend. In the station catchment areas a higher decrease w.r.t. the control area is registered in the time period 2005-2011, while the time period 2011-2016 is characterised by an opposite trend. Therefore, the stations' inauguration has a positive impact on the rent demand.

Area	RF ₂₀₀₅	RF ₂₀₁₁	RF ₂₀₁₆	$\Delta RF\%_{05-11}$	$\Delta RF\%_{11-16}$
University	15,9	8,6	7,1	-46%	-18%
Toledo	16,4	10,3	8,3	-37%	-19%
Garibaldi	10,1	6,2	5,0	-38%	-20%
Municipio	21,3	10,6	8,4	-50%	-21%
Control area	11,8	6,9	5,1	-41%	-26%
Naples average				-31%	-28%

Source: Authors' elaboration

Table 3. Rent percentage change in station catchment and control areas



Source: Authors' elaboration

Figure 10. Rent percentage change in station catchment and control areas

5. Conclusions and further perspectives

In this paper the link between transportation rail interventions and the land use system, in terms of residents and house prices, has been analysed. Specifically, the impacts of the metro lines of the city of Naples in the south of Italy have been evaluated within the stations' catchment areas. The opening of Line 1 of the metro had a significant impact on residents' location. Indeed they preferred to move within these areas considering the increase of zone accessibility and the ending of the works which for years have had a negative influence on the quality of life of the zones under study (mainly around the stations University and Toledo, where the works are now completed). However, house prices did not increase as expected as it was for rents. This behaviour can be explained since the opening of the new stations happened in the same period of the economic crisis, which had an impact on the land market mainly in zones, such as the ones of the new stations, once overestimated being closer to many activities.

Residents' intention to move has mainly been caused by rents' changes. Indeed the increase of rents, in the zones under study, confirms the increasing interest of residents due to the increase of accessibility. Thus in the future it will be necessary to extend the metro network of the city of Naples to zones not currently served in order to get homogenous accessibility values.

In order to support the results obtained further perspectives could consider the specification and calibration of an hedonic pricing model (Rosen, 1974). The latter could help in identifying the impact of the transport variables on residents, house price and rents behaviour in more detail.

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